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Appendices

ASTWG miniretreats and conferences

1 What is ASTWG?

A national working group that identifies future spaceport technology development.

The Advanced Spaceport Technology Working Group (ASTWG) was created to pursue and promote spaceport development activities that will reduce the overall cost of access to space. The vision of ASTWG is a national spaceport architecture that encompasses all current and future spaceports, planned and proposed launch vehicles, and the mission control systems necessary to conduct spaceflight from anywhere in the nation.

ASTWG is devoted to reducing ground-based costs through standardized and simplified flight vehicle interfaces and turnaround facilities by providing both a forum and a framework to define and develop future launch systems. To effectively plan spaceport growth, all stakeholders must participate in the organized and systematic development of spaceport technologies. In this process, the Advanced Spaceport Technologies Working Group will identify and eliminate duplication of effort while gaining synergy among its stakeholders.
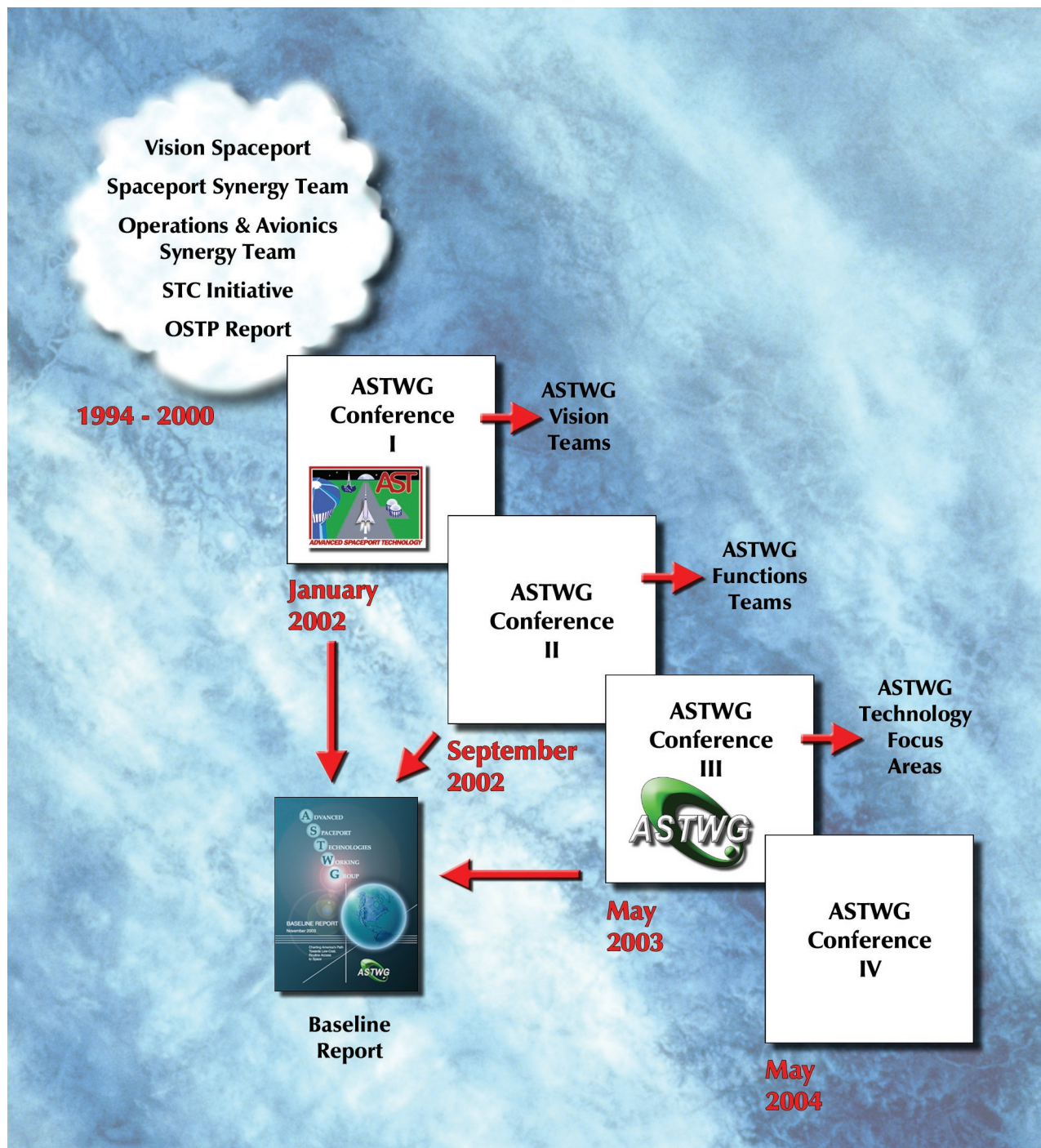
Figure 1. Chronological summary of ASTWG activities

1.1 How did ASTWG come to be?

ASTWG was part of an evolution of spaceport technology development.

The desire to improve the efficiency of ground operations has been around for decades. One method to identify such improvements is to document the ground operations required to process flight hardware and dissect the process into functions and subfunctions performed at a spaceport, similar to a functional breakdown structure. The development of a generic functional breakdown of space transportation operations began in 1994 with a challenge from the government/industry-sponsored Operations and Avionics Synergy Team during the concept definition phase of NASA's X-33 program. The product was known as the Reusable Launch Vehicle (RLV) Operations Concept Vision, which was a generic, vehicle-independent operations concept for future reusable launch architectures that was shared by NASA's Kennedy Space Center (KSC) and its industry partners.

From 1995 through 1997, during NASA's Highly Reusable Space Transportation (HRST) Study, a similar challenge to this informal KSC/industry team produced a "catalog" of generic spaceport functions, or in other words, a generic definition of operations functions that could or must be provided by spaceport infrastructure, regardless of vehicle specifics. Taken together, these two challenges galvanized the "Spaceport Synergy Team" and inspired the formation of a "spaceport" vision.

In 1999, the Spaceport Synergy Team hosted a panel at the National Technology 2009 conference, which brought current and future spaceport users together with spaceport providers for the first time in a formal discussion forum. The panel dialogue attracted the attention of the White House Office of Science and Technology Policy (OSTP), which was in the process of developing an interagency report on the future of U.S. space launch bases and ranges.

The following year, the OSTP's final interagency report included a recommendation to proceed with new range technology development and specifically recommended KSC be designated a National Center for next-generation RLV range technology development.[1] NASA partnered with the U.S. Air Force to formulate the charter for the Advanced Range Technologies Working Group (ARTWG). However, NASA felt that the spaceport needed more attention and combined the results of the previous industrywide efforts with the new KSC-based "Spaceport Technology Center" (STC) to establish a national working group – the Advanced Spaceport Technologies Working Group (ASTWG).

This document presents the results of a series of ASTWG studies and activities. Figure 1 provides a chronological summary of ASTWG-related activities.

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[1] White House Office of Science and Technology Policy, *Fact Sheet: White House Completes Review on Space Launch Ranges,* February 8, 2000, <http://www.ostp.gov/html/0029.html> (October 20, 2003).
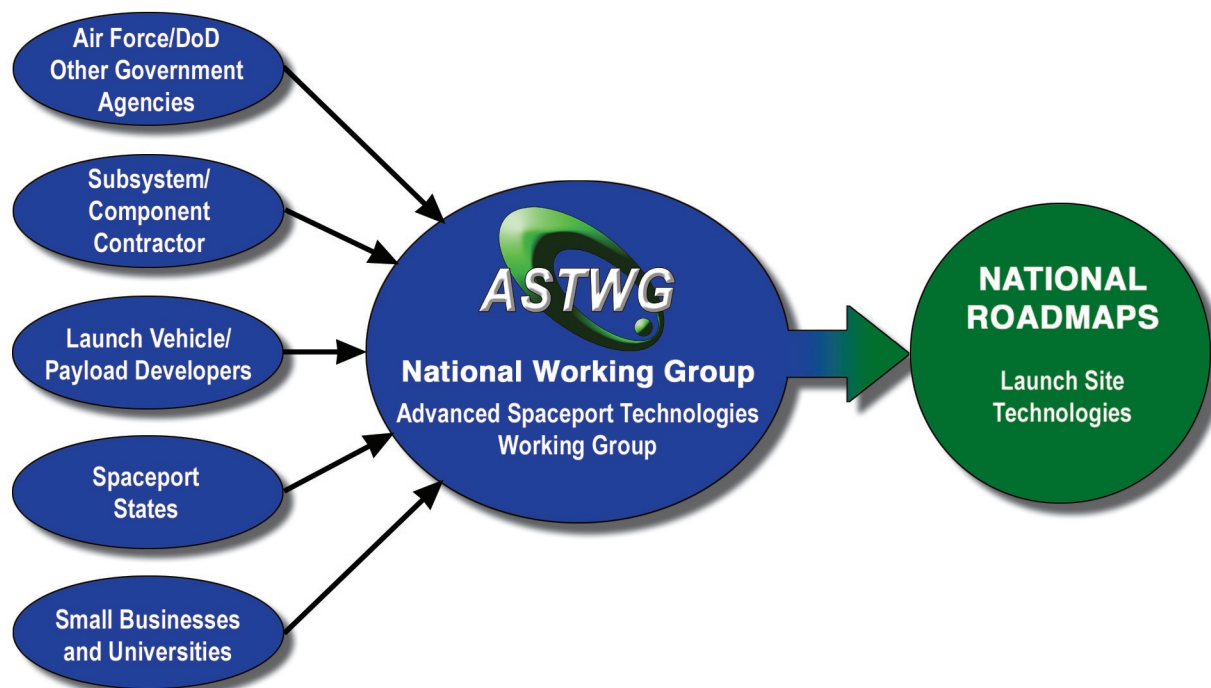
Figure 2. ASTWG stakeholders and product

1.2 Who makes up ASTWG?

ASTWG consists of a comprehensive membership from across U.S. government, industry, and academia committed to improving space access.

As a national working group, ASTWG enables the exchange of information and fosters cooperation within the space access community to identify business and technology gaps and to minimize duplication of technology development efforts. ASTWG is open to all members of the nation's space access community with an interest in the development of future spaceports and presently includes over 250 U.S. citizens.

Membership includes all NASA Centers/programs; other federal government entities, such as the Federal Aviation Administration (FAA), Department of Defense (DoD), and Department of Commerce (DoC); local and state governments; private industry; technology providers; current and future spaceport and range customers; operators and developers (including existing and emerging launch services providers); and academia (see Figure 2 and Appendix A). This diverse community ensures a broad scope of technologies and ideas are assessed as well as a commitment to a unified spaceport vision. The goal of ASTWG is to collect all of the stakeholder requirements and develop national technology roadmaps for launch site operations technologies. These roadmaps will guide the stakeholders in prioritizing the specialized technologies requiring development and testing to most efficiently achieve spaceport visions.

Figure 3. ASTWG organization

1.3 What are the subgroups of ASTWG?

ASTWG is currently organized around three major areas of emphasis:

- *Technology*
- *Commerce Development*
- *Education and Outreach*

The Technology subgroup is responsible for identifying the overall concept of operations for the ideal spaceport – the capabilities and technologies needed to achieve the vision of spaceports operating like airports. The Technology subgroup was originally organized around the functions performed at the spaceport: Flight Element Ope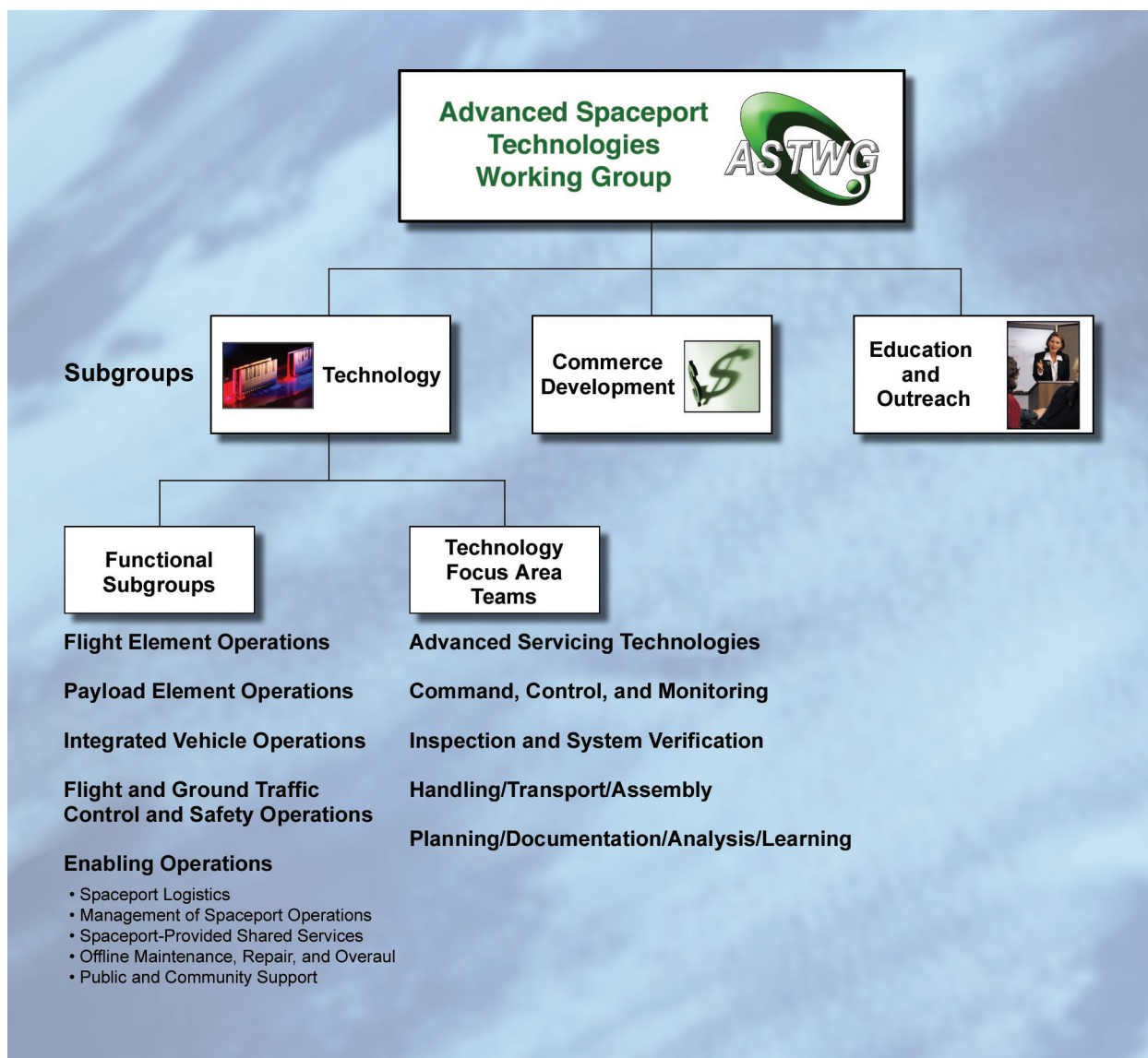rations, Payload Element Operations, Integrated Vehicle Operations, Flight and Ground Traffic Control and Safety Operations, and Enabling Operations (see Figure 3). This functional subgroup had the responsibility to identify the activities or subfunctions typically required to prepare space vehicles and payloads for their departure into space and to define their ideal characteristics. The general ASTWG membership was invited to participate in two technology miniretreats held at Kennedy Space Center. For 10 days, a diverse cross section of the membership (see Appendix B) brainstormed the ideal characteristics of each subfunction of spaceport operations, the challenges associated with achieving these goals, and potential approaches for accomplishing them. The product of the technology miniretreats was a set of spaceport capability roadmaps for all the major functions performed at the spaceport. The roadmaps identify the current and the near-, mid- and far-term characteristics, challenges, and technical approaches of each subfunction. These roadmaps can be found in Appendices D through H.

The Technology subgroup is now operating as technology focus area (TFA) teams, which are developing potential scenarios for accomplishing major goals during spaceport operations and ultimately identifying the technologies required to enable such scenarios. The product of the technology focus area teams is a set of technology roadmaps centered on the respective technology focus areas.

The development of advanced spaceport technologies is essential to enable the safer, lower-cost access to space that will make future spaceports technically and economically viable. However, technology alone cannot enable this vision. Commerce development and public outreach are key components of making a future spaceport a reality.

In support of this goal, the ASTWG Commerce Development subgroup performs economic analysis of spaceports and identifies policy issues. This subgroup will continue to assess existing federal and state policies and regulations that affect spaceport development and exert influence to create new policies or revise old ones. An inventory of current policies and regulations that impact spaceport development with recommendations for revisions necessitated by technology and business developments will be a product of this subgroup.

As important as the policy issues are the economic analyses of spaceports. Defining a strong business plan and communicating the vision of how space utilization can benefit the general public are paramount to the success of any spaceport. The Commerce Development subgroup has taken on the responsibility of defining a national space enterprise vision. This, to the best of our knowledge, has never been accomplished.

The Oklahoma Space Industry Development Association (OSIDA) hosted a miniretreat in Oklahoma City for the ASTWG Commerce Development subgroup, again, inviting the general ASTWG community to participate. A diverse group of individuals (see Appendix B) representing the federal, state, and local governments, private industry, public organizations, and academia gathered to develop a space enterprise model, showing the components for the enterprise and identifying actions to pursue to realize this vision. In addition to the model, different scenarios were developed to exemplify how space is an important utility to the people of the United States and to show the benefits to the average citizen. This group spent two days at the Oklahoma State Capitol developing the current and the ideal space enterprise models and showing how a modern space industry will flow money through its system and return investment to both private and public parties.

And finally, the third team of ASTWG is the Education and Outreach subgroup. The mission of the Education and Outreach subgroup is to promote a greater level of involvement in and access to spaceport education, information, and data for the benefit of the general public and educational institutions.

For spaceports to flourish in the future, each new generation needs to be educated about the broad benefits of space utilization and how it can directly benefit them. Public awareness of spaceport market opportunities is essential to the development of the thriving spaceport enterprise. Developing and sustaining an educated and competent workforce is likewise paramount to spaceport enterprise success. The Education and Outreach subgroup accomplishes its goals by working with other ASTWG subcommittees to determine requirements and then generating opportunities to present the information to the general public, schools, colleges, and universities.

1.4 What are the ASTWG products?

ASTWG produces five groups of products:

- *Operating Plan*
- *Baseline Report*
- *Technology Plan*
- *Commerce Development and Education Plan Concept Papers*
- *Design Guide*

The ASTWG documents are organized to allow readers to easily identify the materials they are most interested in. Figure 4 shows the ASTWG documents and their relationship to each other.

The **ASTWG Operating Plan** will be the guiding plan for the development and revision of all ASTWG documents. It will provide an overall description of the ASTWG approach.

The **ASTWG Baseline Report** is this report. It provides an overall definition and description of a spaceport and the vision of an ideal spaceport. It also contains the ASTWG history, the functional capability roadmap for each spaceport function, the challenges and potential technical approaches associated with achieving the desired capabilities, and an introduction to the technology focus areas. The ASTWG Baseline Report will be reevaluated continually to ensure the vision is still relevant when compared to the present-day environment.

The **ASTWG Technology Plan** will provide the detailed description of the technologies needed to achieve the vision described in the ASTWG Baseline Report. The technology plan will contain scenarios or concepts of operations for the various technology focus areas, the technical hurdles or challenges associated with accomplishing each scenario, and potential technology solutions for each scenario. The ultimate products within the ASTWG Technology Plan will be the technology

roadmaps to guide development of key technologies. The ASTWG Technology Plan will be updated annually, documenting new scenarios and updating the technology roadmaps to address advances in technologies.

The **ASTWG Commerce Development and Education Plan Concept Papers** provide the detailed description of the commerce and education issues related to a successful space industry and spaceports. These concept papers will be published as they are completed.

The **ASTWG Design Guide** for highly reusable launch vehicles integrated with efficient spaceport operations provides design guidance for spacecraft and launch vehicle providers for improved ground operations and maintenance. This guide will provide designers and decision makers information for focusing on key factors and relationships pertaining to the design of flight hardware to make the total space transportation system is operations-friendly. The intent is to aid in strategic decision making. The ASTWG Design Guide will be reevaluated as varying architectures arise.

The ASTWG product update timeline will naturally adjust in response to the changing world environment.

ASTWG Technology Plan

Provides the detailed description of the technologies needed to achieve the vision as described in the ASTWG Baseline Report.

ASTWG Operating Plan

Provides overall description of approach.

ASTWG Design Guide

Provides spacecraft and launch vehicle providers recommendations for the design of the flight hardware to make the space transportation system operations-friendly.

ASTWG Commerce Development and Education Plan Concept Papers

Provide the detailed description of the commerce and education issues related to a successful space industry and spaceports.

Provides overall description of what a spaceport is and the vision of a spaceport.

Figure 4. ASTWG products